wherein the mixture of raw materials contains titanium oxide powder having an average particle diameter of 0.5 μm or less in the range of from 0.1 to 5% by mass in terms of titanium nitride.

20. (Amended) The method of manufacturing a wear resistant member as set forth in claim 17, further comprising a step of:

carrying out a HIP treatment under a pressure of 300 atm or more in a non-oxidizing atmosphere at a temperature in the range of from 1600 to 1850°C.

SUPPORT FOR THE AMENDMENT

The amendments to the claims and the specification were made for the purposes of clarifying the claims and specification and not to distinguish over prior art. The amendments to the claims are made without intending to limit the scope of equivalents of the amended claims. No new matter is believed to be added by entry of these amendments. Claims 1-20 are in the case, of which Claims 1-16 are active.

REMARKS

Applicants would like to thank Examiner Group for the helpful and courteous discussion held with Applicant's representative on February 11, 2003. During the discussion, Applicants noted that the wear resistant member of the present invention contains from 0.2 to 5% by mass of titanium nitride particles having a long axis of 1 μm or less. None of the applied references describe or suggest a silicon nitride in which particles of titanium nitride having a long axis at 1 μm or less is dispersed.

The wear resistant member of the claimed invention comprises a silicon nitride sintered body containing 75-97% by mass of silicon nitride and from 0.2 to 5% by weight of

titanium nitride particles having a long axis of 1 μm or less. The term "long axis" refers to the length of the longest diagonal of a particle of titanium nitride (paragraph 0026). If the long axis of the particle of titanium nitride exceeds 1 μm, properties such as flexural strength, fracture toughness and rolling fatigue life are reduced (paragraph 0024). Thus, improved properties may be obtained by providing titanium nitride particles having a long axis of 1 μm or less. If the titanium nitride particles are prepared by converting a titanium compound such as a titanium oxide, carbide, boride, or silicide, the average particle size of, for example, the titanium oxide raw material should be less than 0.5 μm in order to provide titanium nitride particles having a size within the claimed range (paragraphs 0047-0048).

The rejections of the claims under 35 U.S.C. §§ 102(b) and 103(a) over Suyama (U.S. 5,098,872) and Peuckert (DE 3840171) are respectfully traversed. None of the applied references describe or suggest a wear resistant member having titanium nitride particles with a long axis of 1 μm or less.

Suyama describes a wear-resistant member "mainly consisting of silicon nitride" and "titanium oxide" (column 2, lines 39-43). Suyama fails to expressly describe titanium nitride particles. Suyama does describe preparing a wear-resistant member by sintering a mixture of silicon nitride and a "sintering auxiliary" such as titanium oxide, so that the titanium oxide may react "with silicon nitride to produce titanium nitride" (column 4, lines 1-12). However, as discussed in the present specification (i.e., at paragraphs 0047-0048), only titanium oxide particles having an average particle size of 0.5 μm or less would be expected to provide titanium nitride particles having a long axis of 1 μm or less. Since Suyama is completely silent regarding the particle size of the titanium oxide "sintering auxiliary," Suyama does not inherently describe the claimed wear-resistant member because the process of Suyama would not *necessarily* provide titanium nitride particles having a long axis of 1 μm or less.

Accordingly, Suyama neither expressly nor inherently describes the claimed invention. Applicants respectfully request withdrawal of the rejection.

Moreover, Suyama fails to suggest the claimed wear resistant member. As discussed above, titanium nitride particles having a long axis of 1 μm or less may be formed from titanium oxide particles, provided that the titanium oxide particles have an average particle size of 0.5 μm or less. Since Suyama fails to describe the average particle size of the titanium oxide powder, Suyama cannot reasonably suggest preparing a wear resistant member from a composition containing titanium oxide particles having an average particle size of 0.5 μm or less. Accordingly, Suyama fails to suggest the claimed wear resistant member. Applicants therefore respectfully request withdrawal of the rejection.

Furthermore, as indicated in MPEP 2144.05(ii)(B), "a particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation" (citing *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977)). Since Suyama fails to recognize that the particle size of the titanium oxide, and therefore the particle size of the titanium nitride is a result-effective variable, it would not reasonably be obvious to optimize the average particle size of the titanium oxide in the process of Suyama to provide the claimed wear resistant member.

Likewise, Peuckert describes a silicon nitride ceramic prepared from α-silicon nitride powder, cerium oxide, aluminum oxide, and titanium oxide (English abstract). Peuckert fails to expressly describe a ceramic having titanium nitride particles with a long axis of 1 μm or less. Examples 1-3 of Peuckert describe preparing a silicon nitride ceramic from a composition with titanium oxide powder having an average particle size of 9 μm (page 3, lines 22-23). As discussed above, if the titanium oxide powder has a particle size of greater than 0.5 μm, the resulting titanium nitride particles would be expected to have a particle size

greater than 1 μm. Thus, one would reasonably expect that the process of Peuckert, in which ceramics are prepared from a composition with 9 μm titanium oxide powder particles, would provide a ceramic with titanium nitride particles having a particle size far greater than 1 μm. Thus, Peuckert fails to expressly or inherently describe the wear resistant body of the present invention. Accordingly, Applicants respectfully request withdrawal of the rejection.

Furthermore, Peuckert does not reasonably suggest the claimed invention. As discussed above, the ceramics of Peuckert would be expected to have titanium nitride particles which are significantly larger than 1 μm, resulting in ceramics which would be expected to have significantly poorer properties compared to those of the claimed invention. Accordingly, Applicants respectfully request withdrawal of the rejection.

The rejections of the claims under 35 U.S.C. §112, second paragraph are obviated by appropriate amendment. Claim 1 has been amended as suggested by the Examiner. Claims 2 and 4 have been amended to recite "particles of titanium nitride are dispersed in the silicon nitride sintered body as single particles." Accordingly, Applicants respectfully request withdrawal of the rejection.

REQUIREMENT FOR RESTRICTION

Applicants affirm the election of Group I, Claims 1-16, drawn to a product.

The Office has characterized the inventions of Groups I and II as related as process of making and product made. Citing MPEP § 806.05(f), the Office concludes that the product as claimed can be made by a different process, such as "reaction sintering elemental Si." However, there is no evidence of record to show that the claimed product can be made by "reaction sintering elemental Si" as the Office has alleged. If, in fact, the claimed product can be made by "reaction sintering elemental Si", Applicants respectfully submit that the

Office has not shown how this process is materially different from the claimed process. Accordingly, Applicants respectfully request withdrawal of the restriction requirement.

Applicants note that MPEP § 821.04 states, "if Applicant elects claims directed to the product, and a product claim is subsequently found allowable, withdrawn process claims which depend from or otherwise include all the limitations of the allowable product claim will be rejoined." As amended, process Claims 17-20 now expressly recite the limitations of Claim 1. Since, for the reasons stated above, Applicants respectfully submit that Claims 1-16 are now allowable, Applicants respectfully request that the non-elected Claims 17-20 be rejoined.

Accordingly, and for the reasons stated above, Applicants respectfully submit that the claims are now allowable. Early notification thereof is earnestly submitted.

Respectfully submitted,

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IN THE SPECIFICATION

Please amend paragraph 0012 at page 5 as follows:

[0012] The wear resistant member of the present invention is one comprising a silicon nitride sintered body, the silicon nitride sintered body comprising silicon nitride, titanium nitride particles [of which] having a long axis [is] of 1 μm or less, and a grain boundary phase mainly containing a Si-R-Al-O-N compound (here, R denotes a rare earth element) in the ranges of from 75 to 97% by mass, from 0.2 to 5% by mass and from 2 to 20% by mass, respectively.

Please amend paragraph [0022] at pages 9-10 as follows:

[0022] The silicon nitride sintered body to use as a wear resistant member contains particles of titanium nitride [of which] having a long axis [is] of 1 μm or less in the range of from 0.2 to 5% by mass. When [a] the content of titanium nitride is less than 0.2% by mass, an effect of improving performance due to titanium nitride cannot be sufficiently obtained. On the other hand, when the content of titanium nitride exceeds 5% by mass, flexural strength, fracture toughness and rolling fatigue life of the sintered body deteriorate on the contrary. The content of titanium nitride is more preferable to be in the range of from 0.5 to 4% by mass.

Please amend paragraph [0026] at pages 11-12 to read as follows:

[0026] In consideration of the aforementioned influence of the particles of titanium nitride, in the present invention, the particles of titanium nitride [of which] having a long axis [is] of 1 μm or less are dispersed in the silicon nitride sintered body. The long axis of the particles

of titanium nitride is more preferable to be 0.5 μm or less. The long axis in the present invention is a length of the longest diagonal of the particle of titanium nitride. There is no problem when a size of a particle of titanium nitride can be measured 3-dimensionally. However, it is general practice to use a simplified method. In the simplified method, an enlarged photograph of an arbitrary unit area (100 x 100 μm, for instance) is taken, the longest diagonal of the particles of titanium nitride present in the enlarged photograph being measured as a long axis to use. In particular, also in the shape measurement of the roundish titanium nitride particle described below, the use of an enlarged photograph is effective.

Please amend paragraph [0095] at pages 44-45 as follows:

[0095] As evident from Table 6, it is found that all of the bearing balls involving Embodiments of the present invention have excellent properties. Though not shown in the Table, all of the grain boundary phases are formed of Si-R-Al-O-N compound. In embodiments where MgO is added, the grain boundary phase is formed of Si-R0Al-Mg-O-N compound. There is found neither of the coagulation nor solution of the titanium nitride particles, that is, the titanium nitride particles are [singly] <u>independently</u> dispersed. The difference of the long and short axes of the titanium nitride particles is 0.2 μm or less.

<u>IN THE CLAIMS</u>

Please amend the claims to read as follows:

1. (Amended) [Wear] <u>A wear</u> resistant member, comprising:

a silicon nitride sintered body;

wherein the silicon nitride sintered body [contains] <u>comprises</u> from 75 to 97% by mass of silicon nitride, from 0.2 to 5% by mass of particles of titanium nitride [of which] <u>having a</u> long axis [is] <u>of</u> 1 μm or less and from 2 to 20% by mass of a grain boundary phase

[substantially containing] comprising a Si-R-Al-O-N compound, [(here,] where R [expresses one of] is a rare earth [elements)] element.

2. (Amended) The wear resistant member as set forth in claim 1:

wherein the particles of titanium nitride [each] are [singly particle] dispersed in the silicon nitride sintered body as single particles.

4. (Amended) The wear resistant member as set forth in claim 1:

wherein the particles of titanium nitride [each] are [particle] dispersed in the grain boundary phase.

5. (Amended) The wear resistant member as set forth in claim 1:

wherein at least 80% by volume of the particles of titanium nitride [contain 80% by volume or more of particles of which] have an aspect ratio [is] in the range of from 1.0 to 1.2.

6. (Amended) The wear resistant member as set forth in claim 1:

wherein the particles of titanium nitride [each are 0.2 μm or less in difference of] have a long axis and short [axes] axis which are different by 0.2 μm or less.

8. (Amended) The wear resistant member as set forth in claim 1:

wherein the silicon nitride sintered body has a porosity of [is] 0.5% or less [in porosity] and a maximum pore diameter of 2 μm or less [in a maximum pore diameter].

9. (Amended) The wear resistant member as set forth in claim 1:

wherein the silicon nitride sintered body has a three point flexural strength of [is] 1000 MPa or more [in three point flexural strength] and a facture toughness of 6.5 $MPa{\cdot}m^{1/2}$ or more [in fracture toughness].

10. (Amended) The wear resistant member as set forth in claim 1:

wherein, the wear resistant member has a rolling fatigue life of 1×10^8 times or more when tested with [by the use of] a thrust bearing testing machine, under the conditions of opponent material of a SUJ2 steel ball provided by JIS G4805, a load of 39.2 MPa, and a

number of rotation of 1200 rpm, [when] <u>and the</u> rolling fatigue life is measured until a surface of the wear resistant member is peeled off[, the wear resistant member has the rolling fatigue life of 1 x 10^8 times or more by a number of repetition].

11. (Amended) The wear resistant member as set forth in claim 1:

wherein the wear resistant member comprises <u>a</u> ball member.

12. (Amended) The wear resistant member as set forth in claim 11:

wherein the ball member [is] <u>has a crushing strength of</u> 200MPa or more [in crushing strength] and <u>a facture toughness of</u> 6.5 MPa·$m^{1/2}$ or more [in fracture toughness].

13. (Amended) The wear resistant member as set forth in claim 11:

wherein, <u>the ball member has a rolling fatigue life of 400 hr or more when tested with</u> [by the use of] a thrust bearing testing machine, under the conditions of opponent material of <u>a</u> SUJ2 steel plane table provided by JIS G4805, a maximum contact stress of 5.9 GPa, a ball, and a number of rotation of 1200 rpm, [when] <u>and the</u> rolling fatigue life is measured until a surface of the ball member is peeled off[, the ball member has a rolling fatigue life of 400 hr or more].

14. (Amended) The wear resistant member as set forth in claim 1:

wherein the grain boundary phase [contains] <u>comprises</u> from 0.5 to 10% by mass of a rare earth element in terms of oxide, from 0.1 to 5% by mass of aluminum oxide and 5% by mass or less of aluminum nitride.

15. (Amended) The wear resistant member as set forth in claim 1:

wherein the silicon nitride sintered body [contains] <u>further comprises</u> at least one [of] element selected from <u>the group consisting of</u> magnesium, zirconium, hafnium and tungsten in the range of from 0.1 to 5% by mass in terms of oxide.

17. (Amended) A method of manufacturing <u>the</u> wear resistant member <u>of claim 1</u> [comprising silicon nitride sintered body], comprising the steps of:

[adding, to] mixing silicon nitride powder [that contains oxygen by] comprising 1.7% by mass or less of oxygen and [α-silicon nitride by] 90% by mass or more [and of which] of α-silicon nitride having an average particle diameter [is] of 1.0 μm or less, from 0.5 to 10% by mass of a rare earth compound in terms of oxide, from 0.1 to 5% by mass of titanium nitride [of which] having an average particle diameter [is] of 0.7 μm or less or a titanium compound that [converts into] forms titanium nitride [due to the] by sintering in terms of titanium nitride, from 0.1 to 5% by mass of aluminum oxide and 5% by mass or less of aluminum nitride, thereby providing [are added to prepare a] mixture of raw materials;

molding the mixture of raw materials into a desired shape;

heat treating, after degreasing the molded body obtained [in the step of] after said molding, at a temperature in the range of from 1300 to 1450°C; and

sintering the heat-treated molded body [undergone the heat treatment] at a temperature in the range of from 1600 to 1900°C [to prepare the silicon nitride sintered body].

18. (Amended) The method of manufacturing a wear resistant member as set forth in claim 17:

wherein[,] the mixture of raw materials is added in a plurality of portions to the silicon nitride powder, the titanium nitride or the titanium compound that [converts into] forms titanium nitride due to the sintering [is added divided into a plurality of portions to mix].

19. (Amended) The method of manufacturing a wear resistant member as set forth in claim 17:

wherein the mixture of raw materials contains titanium oxide powder [of] having an average particle diameter of 0.5 μm or less in the range of from 0.1 to 5% by mass in terms of titanium nitride.

20. (Amended) The method of manufacturing a wear resistant member as set forth in claim 17, further comprising a step of:

[implementing] carrying out a HIP treatment under a pressure of 300 atm or more in a non-oxidizing atmosphere at a temperature in the range of from 1600 to 1850°C.